

Density of Pb and Cd in pork at use in rations of different grain mixtures

Yu. Savchenko,

academician of the NAAS, doctor of Agricultural Sciences

I. Savchuk,

doctor of Agricultural Sciences

M. Savchenko,

candidate of Agricultural Sciences

Institute of agriculture of Polissya NAAS

The purpose. To determine accumulation of heavy metals (Pb, Cd) in pork at use of different doses of protein-vitamin-mineral additive (PVMA) in feed grain mixture in conditions of Polissya (III zone of radioactive impurity). **Methods.** 3 groups of experimental pigs were formed: I group (control) — was fed with grain mixture 1 (20% of PVMA); II group (experimental) — was fed with grain mixture 2 (10% of PVMA + 10% of field pea); III group (experimental) — was fed with grain mixture 3 (10% of PVMA + 10% of lupin). Determination of Pb and Cd was carried out using atomic absorption spectrometer «Quant-2A». **Results.** Feeding young pigs with grain mixtures of different contents influenced accumulation of Pb and Cd in the longest muscle of a back and a liver of animals. Density of Pb and Cd in killing products of pigs was below MPC. **Conclusions.** Substitution in grain mixture of 10% (on mass) of PVMA with analogous amount of kibbled grain of field peas and lupin at fattening animals in III zone of radioactive impurity negatively affects quality of pork, increasing in it density of Pb and Cd (for 10,5-57,9 and 33,3% accordingly).

Keywords: *pork, protein-vitamin-mineral additive, field pea, lupin, lead, cadmium.*

Formulation of the problem. Pollution of the environment by heavy metals has increased 2,5-3 times in recent years and is projected to grow [4]. Anthropogenic pollution has led to the involvement of a large number of extraneous substances, mainly heavy metals, in the planetary biogeochemical cycles. Biogeochemical cycles annually receive 3×10^5 tons of lead, 2×10^3 tons of cadmium [1]. Ukraine is 3,0-6,5 times higher than the USA and developed countries in Europe for man-made chemical loads [9].

The imbalance of rations with respect to basic and biologically active substances, in particular, microelements, vitamins, essential amino acids, does not ensure optimal productivity of animals and poultry, leads to the accumulation of harmful substances in livestock products [6, 7, 11].

In the practice of feeding animals to cover the deficit of individual nutritional elements in rations, various premixes, protein-vitamin-mineral supplements (PVMA), mixtures of microelements and vitamins are used in rations. Protein-vitamin-mineral supplements, namely, mineral elements and vitamins, which are part of their composition, participate in the processes of digestion and synthesis of substances in the animals. They create the necessary conditions for the normal functioning of enzymes and hormones, maintain acid-base balance and osmotic pressure at the required level [2, 3, 5, 8].

Therefore, the enrichment of grain mixtures and mixed fodders with mineral-vitamin additives and other biologically active substances can significantly affect the increase in the conversion of feed nutrients and promote the growth of animal productivity and reduce the accumulation of radionuclides and heavy metals in livestock production in the zone of radioactive contamination.

Research objective research was to study the effectiveness of the use of various doses of BVMD in the composition of grain mixtures in the production of pork in the Polissya of Ukraine, the influence of the feed factor on the accumulation of Pb and Cd in products.

Materials and methods of research. The study was carried out in the conditions of the physiological yard of the Institute of Agriculture of Polesye of the National Academy of Sciences of the NAAS (Grozino village, Korostensky district, Zhytomyr region). To carry out the scientific and production experience, young pigs of a large white breed were selected, formed into 3 groups according to the principle of paralogues, taking into account the origin, age, live weight, growth intensity during the equalizing period. The scheme of the research is given in table 1.

The youngest I (control) group received the main ration during the research period, which was prepared in the production conditions (% by weight): wheat bran - 40, barley bran - 40, PVMA - 20. The animals of groups II and III were fed a grain mixture of such of the same composition, but in which instead of 10% of the protein-vitamin-mineral supplement, a similar amount, respectively, of peljushka and lupine was administered. Cereal concentrates for feeding experimental pigs used their own production, grown in the III zone of radioactive contamination due to the Chernobyl nuclear power plant accident.

1. Scheme of scientific and economic experience

Groups of animals	Number of animals in the group, goals	Periods of experience	
		leveling (31 days)	research (156 days)
I - control	7	OR (main diet) - grain mixture № 1: barley bran + wheat bran + PVMA	OR grain mixture № 1: barley bran + wheat bran + PVMA
II - research	7	OR	OR – grain mixture № 2: barley bran + wheat bran + peljushka bran + PVMA
III – research	7	OR	OR – – grain mixture № 3: barley bran + wheat bran + lupines bran + PVMA

On average, during the day, the experimental youngsters of all groups consumed the same amount of food – 2,194 kg of grain mixture. Nutrition of 1 kg of the grain mixture was 1,11-1,14 kg of feed units with a content of 109-121 g digestible protein. The provision of the feed unit of the digestible protein for the experimental groups of animals was somewhat different and varied within the limits of 96-106 g.

According to the average daily intake of vital amino acids, macro- and microelements and vitamins into the body of pigs, there are also significant intergroup differences. Thus, the youngest of the control group compared to the analogues of the research groups consumed more per day: lysine - by 5,1-15,4%, methionine + cystine – 10,2-17,4, Ca – 64,0-65,2, P – 26,3-30,4, Cu – 16,5-17,7, Zn – 4,5-16,5, Co – 11,9-15,8, vitamin E – 18,4-25,8, vitamin B₁ – 14,1-16,5, vitamin B₂ - in 66,7-72,4%.

The preparation of samples of plant and animal origin for the determination of heavy metals was carried out by the method of dry mineralization, the analysis was performed with the «Kvant-2A» atomic absorption spectrometer.

Results of the research. It has been established by studies that in fodder grain mix that were used for fattening young pigs, the content of heavy metals (Pb, Cd) was insignificant and did not exceed the LPC (table 2). The largest concentration of lead was in grain mix №3, which included the bran of lupines (0,058 mg / kg), and cadmium - in grain mix №2 with bran peljushka (0,031 mg / kg).

2. Concentration of heavy metals in feed, mg/kg of natural food

Stern	Heavy metals	
	Pb	Cd
Grain mixture: №1	0,048	0,013
№2	0,033	0,031
№3	0,058	0,026
LPC	5,0	0,3

The mineral composition of the animal organism largely depends on the chemical elements contained in the environment and comes with food. Based on the concentration of lead in feeds consumed by experimental animals, its daily average intake of pigs for fattening and transition to production has been determined (table 3).

As a result of the conducted studies it was established that in the slaughter products of pigs of all experimental groups, the accumulation of Pb was significantly less than the LPC (0,50-0,60 mg/kg), while the concentration of this heavy metal in the long back muscle of the young research groups as compared to the control groups analogues increased by 0,002-0,011 mg/kg, or by 10,5-57,9%. In the liver, the animals of groups II and III with respect to the control of lead content were also large in 1,03-1,19 times.

The coefficient of transition of Pb to meat of the piglet of the control group was lower in comparison with the analogs of groups II and III, respectively, by 11,08 and 5,53% absolute. For the liver, it was 55,24% (in animals of group I) and 47,24-95,83% (in analogues of research groups).

Cadmium is one of the most dangerous toxicants, which is not among the vital elements. This metal accumulates in the body of animals and humans, mainly in the kidneys, liver, bones, disrupting their function. The distribution of cadmium in the food chain (soil - plant - animal - human) in places of pollution causes a risk to health of animals and humans [10].

3. Concentration of Pb in feed rations and slaughtering products of pigs

Groups of pigs	Concentration of Pb in:				Coefficient of transition, %
	the average daily ration, mg	production, mg/kg	± to the control group		
			mg/kg	%	
The longest muscle in the back					
I - control	0,105	0,019±0,02	-	-	18,09
II - research	0,072	0,021±0,005	+0,002	+10,5	29,17
III – research	0,127	0,030±0,010	+0,011	+57,9	23,62
LPC	-	0,50	-	-	-
Liver					
I - control	0,105	0,058±0,023	-	-	55,24
II - research	0,072	0,069±0,018	+0,011	+19,0	95,83
III – research	0,127	0,060±0,006	+0,002	+3,4	47,24
LPC	-	0,60	-	-	-

The amount of cadmium entered the body of the experimental young pigs of a large white breed with fodder rations was significantly less than lead and amounted to 0,028-0,068 mg/day (table 4).

The conducted studies showed that both the pork and liver of animals of all experimental groups did not exceed the maximum allowable concentration for cadmium (respectively 0,05 and 0,30 mg/kg) - their level was within the range of 0,003-0,004 mg/kg and 0,011-0,013 mg/kg.

The intergroup difference in the content of Cd in production was found to be insignificant, depending on the feeding of fattening pigs in the composition of rations of different composition of grain mixes: in the long muscle of the back of the young group II, relative to groups I and III, this index was 33,3% higher, and in the liver of animals III (experimental) group is less by 15,4% than in other experimental groups.

The coefficients of the transition of cadmium from fodder rations to meat varied within the range of 5,26-10,71%, in the liver – 19,12-46,43% and were accordingly large 4,83-5,45% and 27,13 -27,31% absolute in the control group than in the experimental groups.

4. Content of Cd in feed rations and slaughter products of pigs

Groups of pigs	Concentration of Cd in:				Coefficient of transition, %
	the average daily ration, mg	production, mg/kg	± до контрольної групи		
			мг/кг	%	
The longest muscle in the back					
I - control	0,028	0,003±0,001	-	-	10,71
II - research	0,068	0,004±0,001	+0,001	+33,3	5,88
III – research	0,057	0,003±0,001	-	-	5,26
LPC	-	0,05	-	-	-
Liver					
I - control	0,028	0,013±0,001	-	-	46,43
II - research	0,068	0,013±0,001	-	-	19,12
III – research	0,057	0,011±0,001	-0,002	-15,4	19,30
LPC	-	0,30	-	-	-

Based on the studies, certain regularities in the transformation of heavy metals into pig slaughter products have been identified. Thus, according to our data, the transition coefficients of individual metals were (%):

- in the longest muscle of the back: Cd – 5,26-10,71; Pb– 18,09-29,17;
- in the liver: Cd - 19,12-46,43; Pb– 47,24-95,83.

This allows us to state that among the toxicant metals studied, high migratory and deposited activity in the long muscle of the back and liver is characterized by lead. Its conversion rates to pig slaughter products were higher in comparison with cadmium by 2,06-3,44 times.

Thus, the replacement of 10% by weight of the protein-vitamin-mineral supplement in the composition of the forage mix by a similar amount of pea or lupine derti when feeding young pigs in the zone of radioactive contamination adversely affected the quality of pork, increasing the concentration of heavy metals in it, in particular cadmium and lead.

Conclusions

The content of heavy metals (Pb and Cd) in the long back and liver muscle of the experimental pigs was 0,019-0,030 and 0,003-0,004 mg/kg and 0,058-0,069 and 0,011-0,013 mg/kg, respectively, not exceeding the maximum allowable concentration. However, when a 10% by weight protein-vitamin-mineral supplement is substituted for a similar amount of diaper or lupine in the feed mix, a greater accumulation in the long back muscle of the animals of groups II and III is observed compared with the control analogues of lead and cadmium, respectively 10,5-57,9% and 33,3%.

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